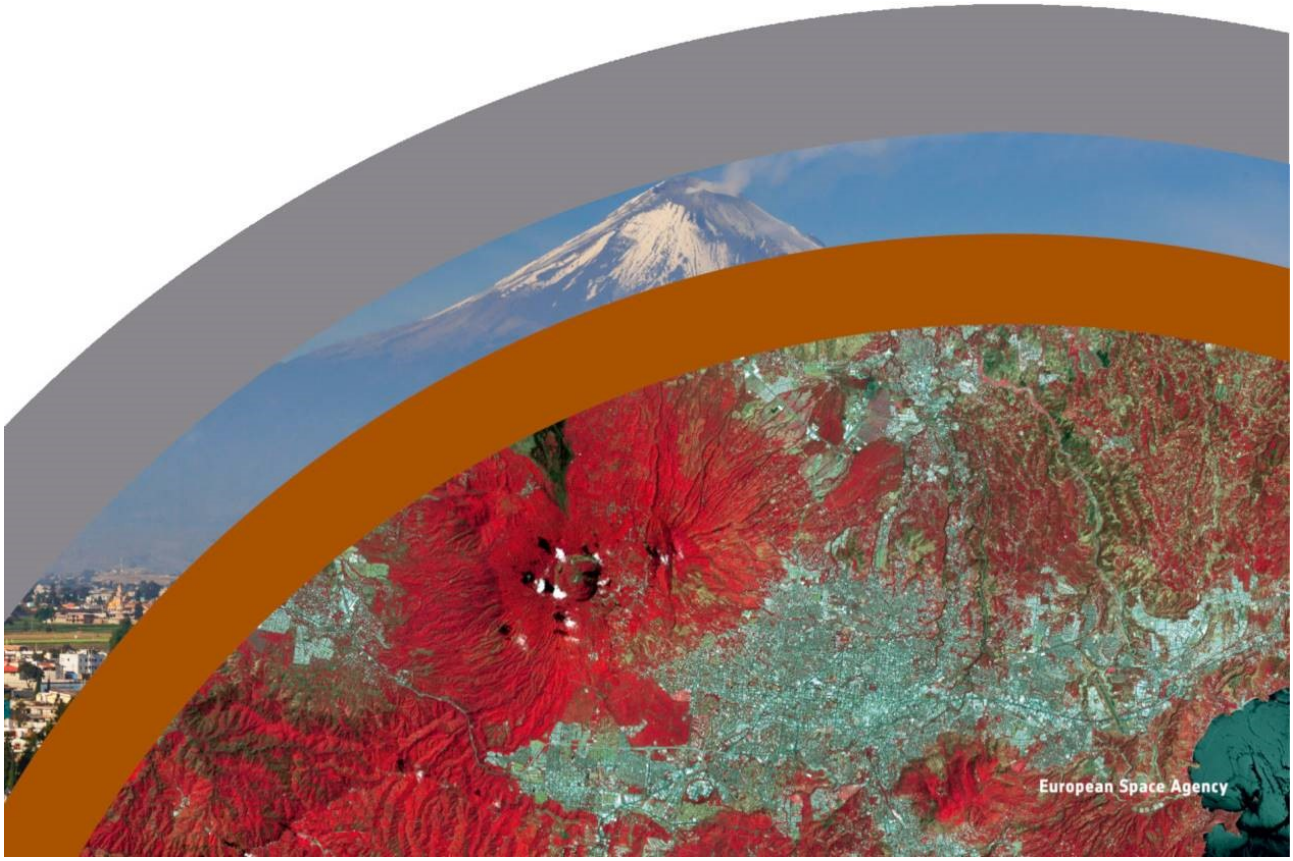
→ EO4SD - EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Disaster Risk Reduction

Mozambique: EO-based services to enhance resilient reconstruction in cyclone affected areas



ESA´s EO4SD Disaster Risk Reduction

Earth Observation for Sustainable Development Disaster Risk Reduction (EO4SD DRR) is an activity initiated by European Space Agency (ESA) in the framework of its collaboration with International Financing Institutions (IFI´s) to support a greater use of satellite Earth Observation (EO) in applications related to the management of natural and man-made hazards and risks.

Disasters cause human suffering, environmental harm, and economic loss; investing in its prevention and reduction will diminish people's vulnerability, saving lives and reducing economical damage.

The impact of disasters on lives and economy are of prime importance to society, especially for developing countries, where the mortality and economic losses are disproportionately high and where development achievements can be threatened. Many types of natural disasters can affect the humankind worldwide: Geo-hazards like earthquakes and volcanoes; hydro-meteorological hazards like floods, hurricanes, tropical storms and storm surges; climatological events like droughts, heatwaves and wildfires among others. There is the need of addressing the impact of these events not only by reacting after episodes but also by enhancing prevention and preparedness. Earth Observation can contribute to tackling most of these natural hazard types efficiently by providing hazard mapping, supporting services for the assessment of exposure, vulnerability and risk and reconstruction monitoring.

Since 2008 ESA has worked closely with Multilateral Development Banks (MDBs) and their Client States to harness the benefits of Earth Observation in global sustainable development increasing the uptake of EO-based information in regular development operations at national and international level

ESA´s funded EO4SD Disaster Risk Reduction project aims to promote the adoption of Earth Observation-based products and services mainstreamed into the working processes of IFIs funded projects that seek to prevent or mitigate the adverse impacts of natural disasters in developing countries. Earth Observation applied to disasters is evolving quickly and has proven to be effective in all phases of the disaster risk management cycle such as prevention/ preparedness, early warning, post event recovery and reconstruction activities.

The authors of this information include the production, coordination and supervision teams from Indra and ESA.

EO-based services to enhance resilient reconstruction in cyclone affected areas

Mozambique after cyclones Idai and Kenneth

As per the World Meteorological Organisation[1], a tropical cyclone is a storm originating over tropical oceans from where it draws the energy to develop. It has a low pressure centre (where the weather is normally calm and free of clouds) and clouds spiralling towards the eyewall surrounding it. Its diameter is typically around 200 to 500 km, but can reach 1000 km and brings very violent winds, torrential rain, high waves and, in some cases, very destructive storm surges and coastal flooding to the affected area. Tropical cyclones are one of the biggest threats to life and property.

In March and April 2019, Mozambique was struck by two consecutive major cyclones with significant impacts on local populations, business and core infrastructure. The first event, Cyclone Idai, affected more than 1.5 million people (5.4 percent of Mozambique population) and cyclone Kenneth, affected around 250,000 people.

Both cyclones caused serious damage to housing and public buildings leading to displacement and disruption of key public sector services, including markets, schools and health facilities with possible long-term negative impacts on people's lives. Impacts of Cyclone Idai and Cyclone Kenneth are concentrated in the provinces of Sofala, Zambezia, Manica, Nampula, Tete and Cabo Delgado.

A Post Disaster Needs Assessment (PDNA) was carried out in collaboration with the Government of Mozambique, United Nations (UN), African Development Bank (AfDB), European Union (EU) in April and May 2019 quantifying the damages, losses and negative repercussions on poverty and economic growth.

Main identified issues

After the PDNA carried out for determining the physical damages, economic losses, and costs of meeting recovery needs and seven months after Cyclone Idai and almost six months after Cyclone Kenneth hit Mozambique, the country was still dealing with the devastating consequences of these two major disasters aiming at accelerating the resilient reconstruction of households and infrastructures

EO4SD-DRR in Mozambique

Taking into account the situation of the country after cyclones Idai and Kenneth (in the province of Cabo Delgado cyclone Kenneth triggered a landfall (25/04/2019) before torrential rains followed, causing flash and riverine flooding (28/04/2019) and in the province of Sofala cyclone Idai triggered a landfall (14/03/2020) before torrential rains followed (14-17/03/2020), causing rivers to overflow), EO4SD-DRR within its collaboration with The World Bank Disaster Risk Management team in Mozambique and the Post-cyclone Idai Reconstruction Office (GREPOC) has aimed at Assessing the reconstruction status of the two affected areas of both cyclones.

Aim of the collaboration

To assess the reconstruction efforts that have been done regarding basic habitability of the areas, focusing on improvements on individual buildings

Results intend to be a tool for decision makers to evaluate the works made so far to bring the affected areas to the status before the disastrous event.

The total area under analysis covered 190,4 Km^2.

[1] https://public.wmo.int/en/our-mandate/focus-areas/natural-hazards-and-disaster-risk-reduction/tropical-cyclones

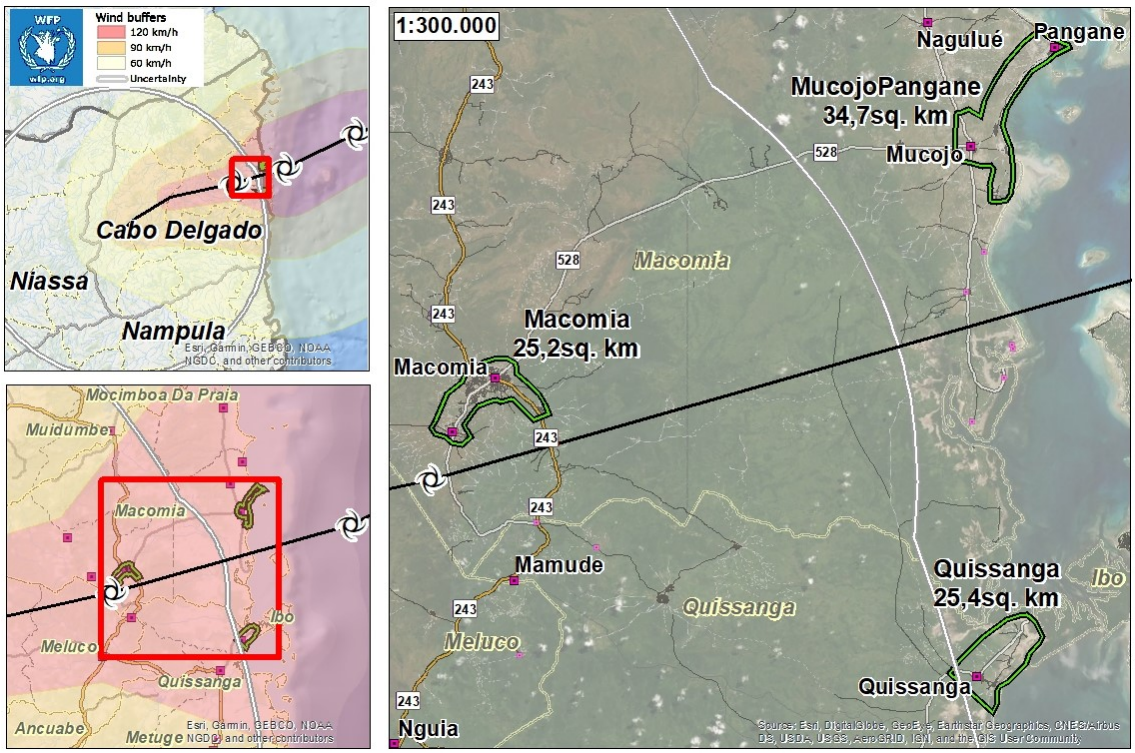


Figure 1 Group 1 AOIs location with respect to cyclone Kenneth track

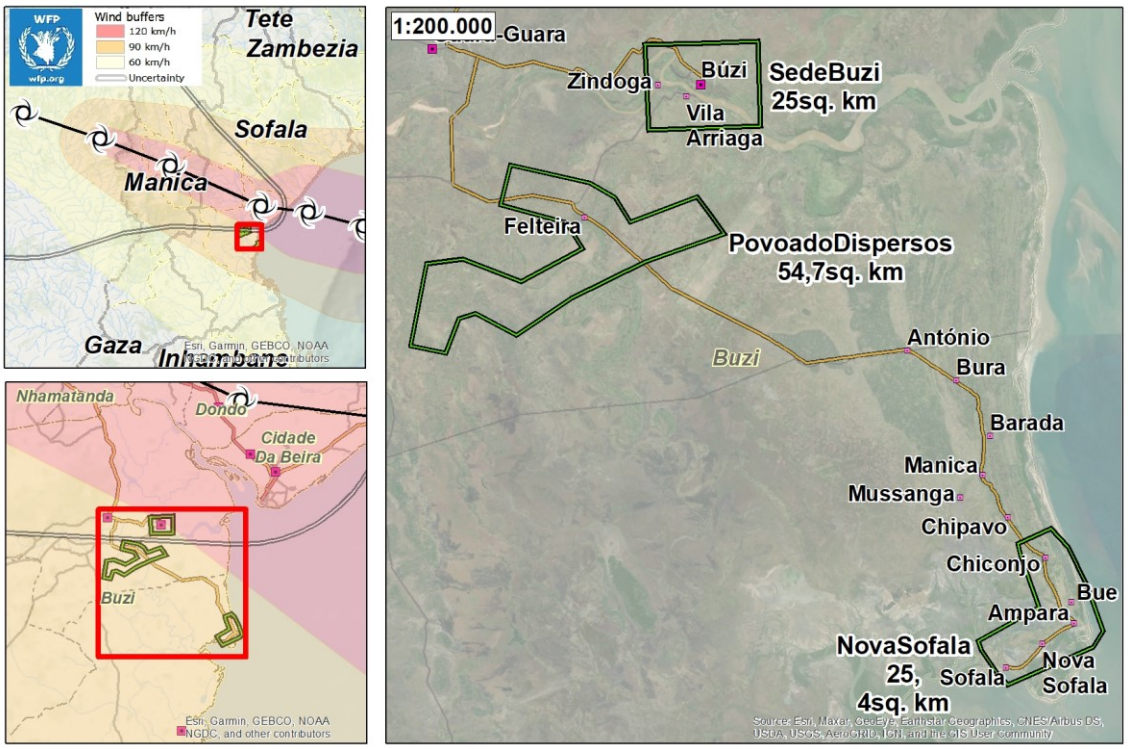


Figure 2 Group 2 AOIs location with respect to cyclone Idai track

Reconstructing Mozambique´s urban areas

In light of the damage caused by cyclones Idai and Kenneth on Mozambique´s coastal urban areas, EO4SD has carried out a building-based damage assessment. The aim of the collaboration was to produce actionable information for supporting resilient reconstruction, “Building Back Better”, in cyclone-affected areas.

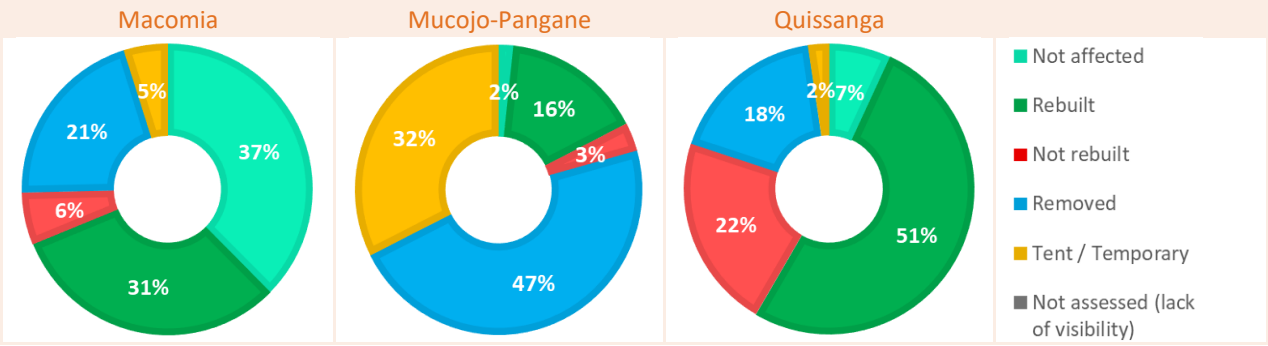
EO4SD-DRR aimed at highlighting the value of EO-data for a damage and reconstruction assessment, in this case, based on Very High Resolution (VHR-1, GSD <= 1m) data. The assessment run a comparison of images of the same area of different dates, focusing primarily on buildings. The first images (T1), are taken, ideally, a short time after the cyclone hit the area (first image available after the event). The second set of images (T2), for this specific case, has been after a year of the event.

Using EO4SD-DRR data, the Post-cyclone Idai Reconstruction Office (GREPOC) as well as the World Bank DRR and UN-Habitat teams in Mozambique have had access to precise information on where the reconstruction efforts have been more effective as well as where more intense investment is needed. This helps the users involved as well as the Disaster Risk Management teams of The World Bank to target interventions that improve reconstruction efforts for the benefit of next events.

The results can be analysed separately in the two areas of interest studied. For group 1, **Macomia** covers 25.2 Km^2. It is the main town in the district and hosts critical infrastructures such a hospital and an electric substation. Traditional housing is common; however, it is frequent to find bigger buildings, and more solid constructions, what can explain the high percent of buildings (39%) where no evidences of damage after Kenneth (**Figure 3**). **Mucojo-Pangane** extends along thirteen kilometres of the coast. **Quissanga** is of the same size than Macomia and it contains a secondary populated place. In Quissanga the cluster observed a significant advance in the reconstruction (53%) .

Table 1 shows the great differences between the AOIs of group 1 showing the percent of each reconstruction class separately. 37% of the buildings in Macomia were Not affected, 47% have been Removed. In Mucojo-Pangane, 32% of Tents and Temporary structures remain at T1, and 51% of the buildings in Quissanga that present evidences of being rebuilt. The percentage of New buildings in Macomia is of 644 (19%), in Mucojo-Pangane 624 (11%) and in Quissanga 362 (15%).

Table 1 Reconstruction status graphs, percent of buildings in each reconstruction class



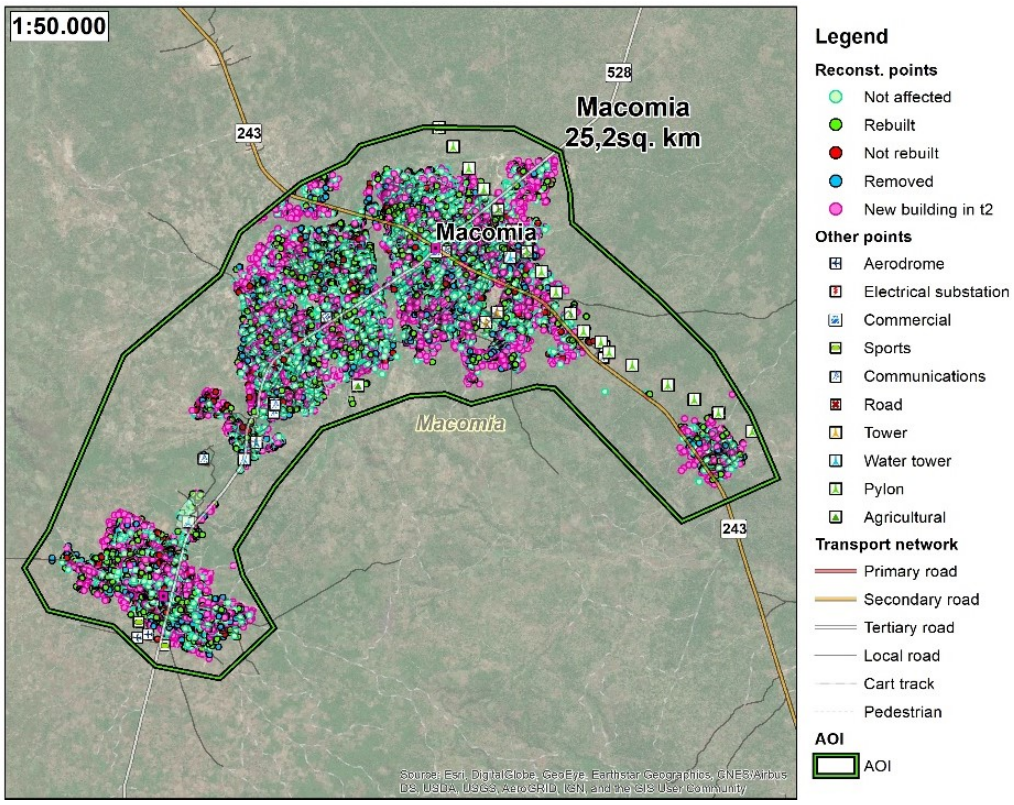
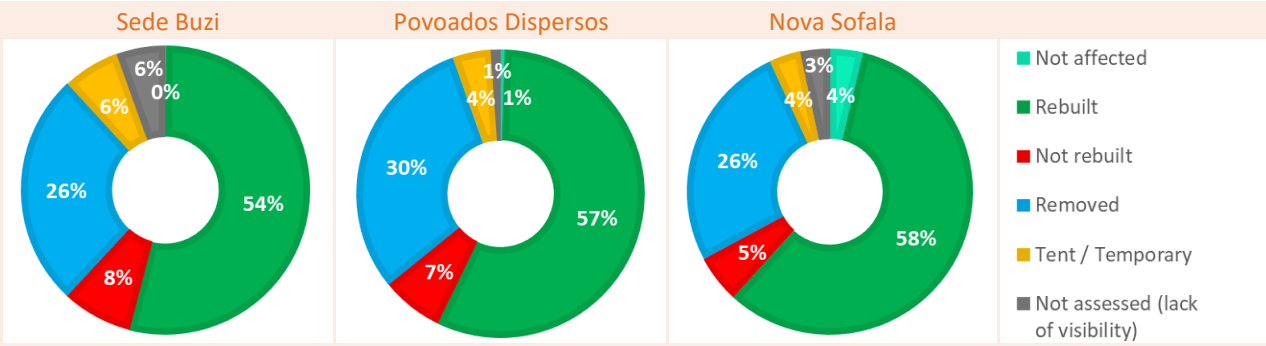


Figure 3 Macomia, reconstruction status map

Regarding Group 2, unlike in AOIs affected by Kenneth, results show very similar distributions. In the three AOIs of Sede Buzi, Povoados Dispersos and Nova Sofala, rebuilt class is around 55% (±3), not rebuilt class represents the 7% (±2), removed class is around 38%, and around a 5% of the observed buildings look as tents or temporary small structures. The graphs in **Table 2¡Error! No se encuentra el origen de la referencia.** confirm the similarity between the AOIs showing the percent of each reconstruction class separately. It is especially worth to mention the percent of the buildings under "Not assessed" class is due to cloud coverage in T2 images.

Table 2 Reconstruction status graphs, percent of buildings in each reconstruction class



Sede Buzi (**Figure 4**) covers an area of 25 Km^2 and is the main populated place, being also one of the most severely affected. It concentrates the majority of the buildings and there is a main power line crossing the town from east to west. Moreover, the town holds a Hospital facility and three Educational facilities. There is also a water tower and three communication towers. Buzi town is connected to the southern bank of the river by a barge that allow vehicle crossing.

Terrestrial transportation infrastructure in Buzi district is very weak, and is highly dependent on weather conditions. Buzi is connected to Beira city by road and there is also a ferryboat from Beira port with frequent service, and an unpaved runway in the southern bank of the river, whose functionality is unknown.

Povoados Dispersos is 54.4 and hosts the populated place of Felteira, at the north, and a dispersed number of buildings that do not really concentrate in the form of villages. The name given, Povoados Dispersos, reflect this. Its elevation is very low, making it very susceptible to flooding.

Nova Sofala is 25 Km^2 hosts a number of dispersed villages (Chiconjo, Faquira, Bue, Ampara, Danga, Nova Sofala and Sofala), whose houses are mainly along the main road that crosses the area from north to south-west. The elevation is also very low, and it is between the Ocean and the wetlands of the river mouth that form Sofala Bay, making it very susceptible to flooding. In Nova Sofala, the majority of the constructions look functional, and were classified as reconstructed (58%). The majority of the buildings in this area are traditionally built as huts, this traditional way of construction, the isolated condition of the AOI, and the easy access to the natural building materials, may have enhanced reconstruction tasks in the AOI.

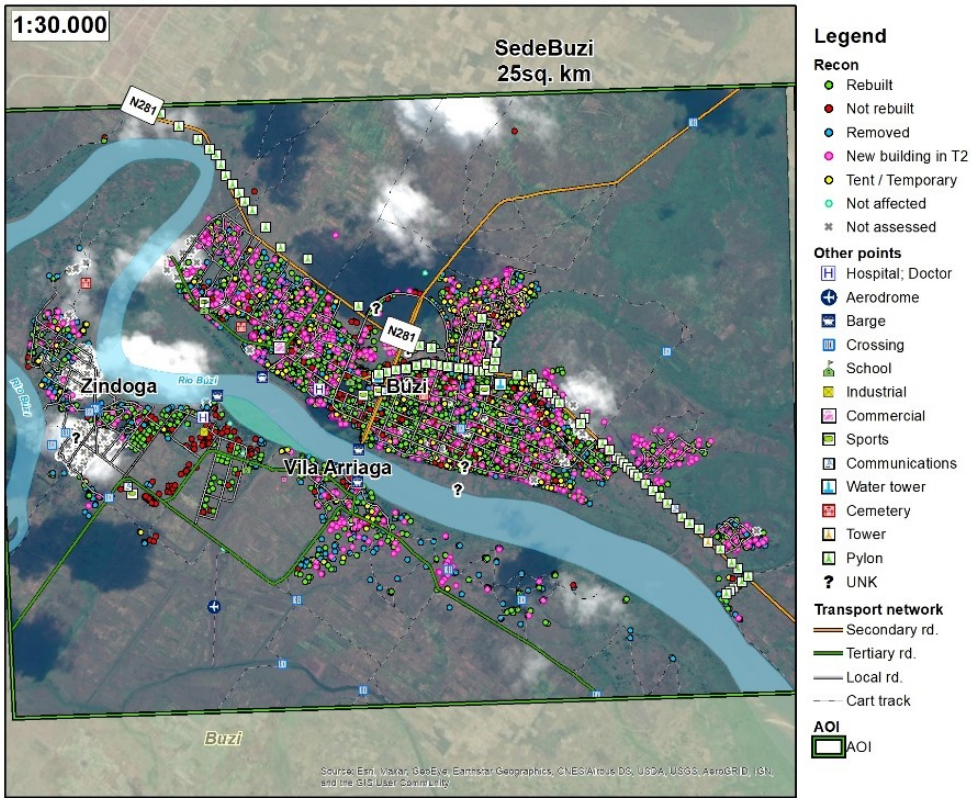


Figure 4 Sede Buzi, reconstruction status map

Earth Observation is already used in many ways to support disaster risk management. Regarding a post disaster situation, a disaster damage and reconstruction assessment is generally used to support crisis management and focus the recovery.

The results provided to the Post-cyclone Idai Reconstruction Office (GREPOC) as well as the World Bank DRR and UN-Habitat teams in Mozambique are useful to focus the following reconstruction efforts, identifying where more effective works have been carried out to date as well as where more intense investment is needed, helping to target interventions that improve reconstruction efforts for the benefit of next events.

EO4SD-DRR within this collaboration has aimed also at reflecting the vulnerability changes on buildings and infrastructure, as while becoming less stable or not being taken care off for a relatively long time, they may represent a threat in case another adverse event occurs.

Understanding disaster risk in all its dimensions of vulnerability, exposure of persons and assets, hazard characteristics and the environment is the first priority action of the Sendai Framework for Disaster Risk Reduction (2015-2030).

International Financial Institutions (IFIs) play a significant role as facilitators of funding in developing countries, in direct cooperation with national mandated disaster authorities to prevent and mitigate the adverse effects of natural disasters and foster sustainable development.

The ESA EO4SD Disaster Risk Reduction project aims to promote the adoption of Earth Observation-based products and services mainstreamed into the working processes of IFIs funded projects that seek to prevent or mitigate the adverse impacts of natural disasters in developing countries. Earth Observation applied to disasters is evolving quickly and has proven to be effective in all phases of the disaster risk management cycle such as prevention/ preparedness, early warning, -post-event recovery, and reconstruction activities.

Consortium partners

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